National Institute of Environmental Health Sciences

Sulfur dioxide initiates global climate change in four ways

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Abstract:

Global climate change, prior to the 20th century, appears to have been initiated primarily by major changes in volcanic activity. Sulfur dioxide (SO2) is the most voluminous chemically active gas emitted by volcanoes and is readily oxidized to sulfuric acid normally within weeks. But trace amounts o SO2 exert significant influence on climate. All major historic volcanic eruptions have formed sulfuric acid aerosols in the lower Stratosphere that cooled the earth's surface similar to 0.5 degrees C for typically three years. While such events are currently happening once every 80 years, there are times in geologic history when they occurred every few to a dozen years. These were times when the earth was cooled incrementally into major ice ages. There have also been two dozen times during the past 46,000 years when major volcanic eruptions occurred every year or two or even several times per year for decades. Each of these times was contemporaneous with very rapid global warming. Large volumes of SO2 erupted frequently appear to overdrive the oxidizing capacity of the atmosphere resulting in very rapid Warming. Such warming and associated acid rain becomes extreme when millions of cubic kilometers of basalt are erupted in much less than one million years. These are the times of the greatest mass extinctions. When major volcanic eruptions do not occur for decades to hundreds of years, the atmosphere can oxidize all pollutants, leading to a very thin atmosphere, global cooling and decadal drought. Prior to the 20th century, increases in atmospheric carbon dioxide (CO2) followed increases in temperature initiated by changes in SO2. By 1962, man burning fossil fuels was adding SO2 to the atmosphere at a rate equivalent to one "large" volcanic eruption each 1.7 years. Global temperatures increased slowly from 1890 to 1950 as anthropogenic sulfur increased slowly. Global temperatures increased more rapidly after 1950 as the rate of anthropogenic sulfur emissions increased. By 1980 anthropogenic Sulfur emissions peaked and began to decrease because of major efforts especially in Japan, Europe, and the United States to reduce acid rain. Atmospheric concentrations of methane began decreasing in 1990 and have remained nearly constant since 2000, demonstrating an increase in oxidizing capacity. Global temperatures became roughly constant around 2000 and even decreased beginning in late 2007. Meanwhile atmospheric concentrations of carbon dioxide have continued to increase at the same rate that they have increased since 1970. Thus SO2 is playing a far more active role in initiating and controlling global warming than recognized by the Intergovernmental Panel on Climate Change. Massive reduction of SO2 should be a top priority in order to reduce both global warming and acid rain. But man is also adding two to three orders of magnitude more CO2 per year to the climate than one "large" volcanic eruption added in the past. Thus CO2, a greenhouse gas, is contributing to global warming and should be reduced. We have already significantly reduced SO2 emissions in order to reduce acid rain. We know how to do it both technically and politically. In the past, sudden climate change was typically triggered by sudden increases in volcanic activity. Slow increases in greenhouse gases, therefore, do not appear as likely as currently thought to trigger tipping points where the climate suddenly changes. However we do need to start planning an appropriate human response to future major increases in volcanic activity.

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Air Pollution, Temperature, Unspecified Exposure

Air Pollution: Other Air Pollution

Air Pollution (other): SO2

Temperature: Fluctuations

Geographic Feature:

resource focuses on specific type of geography

None or Unspecified

Geographic Location:

resource focuses on specific location

Global or Unspecified

Health Impact:

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology:

type of model used or methodology development is a focus of resource

Exposure Change Prediction, Other Projection Model/Methodology

Other Projection Model/Methodology: various climate models

Resource Type:

format or standard characteristic of resource

Research Article, Review

Timescale:

time period studied

Historical